

# Project

- Pick a partner and build a pulley system with string, weight, and a spring scale.
- Switch with another group's system and see if you can predict the reading on the spring scale without looking at it.
- Be able to explain how you were able to make your predictions.

## **Lesson #45**

### **Topic: Problem solving with tension**

**Objectives:** (After this class I will be able to)

1. Practice more complicated system and tension problems

### **Warm Up: Review Evaluation**

**(Get out a separate blank sheet of paper and put your name at the top)**

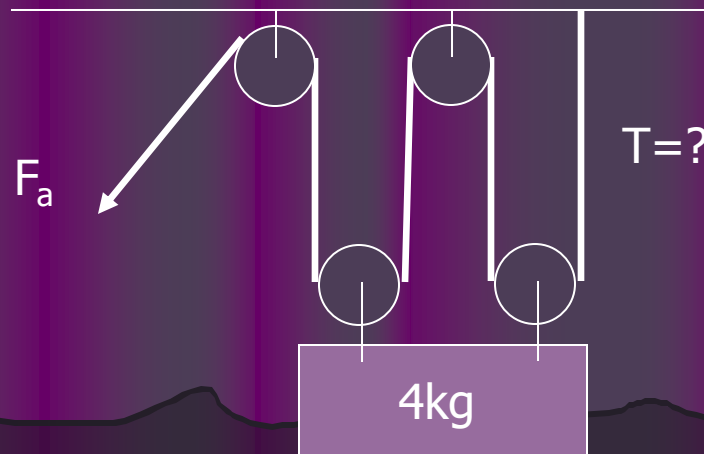
**Assignment:** Corrected "Tension" due tomorrow!

# Review Evaluation

1. What is the tension in the string?



2. What is the tension in the string?



# Review Evaluation



3. What is the normal force acting on block #2?
4. What is  $F_{1 \text{ on } 2}$ ?
5. What is  $F_{2 \text{ on } 1}$ ?

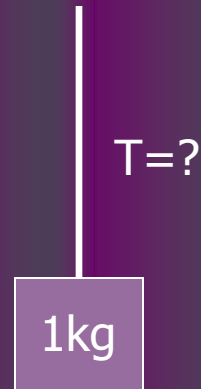
# Review Evaluation



6. What is the acceleration of the system?
7. What is the net force acting on each individual object?
8. What is  $F_{2 \text{ on } 3}$  ?
9. What is  $F_{1 \text{ on } 2}$ ?

# Review Evaluation

The block is accelerating **downward** at a rate of  $1\text{m/s}^2$ .



10. Find the net force acting on the block.
11. Find T.

# Review Evaluation



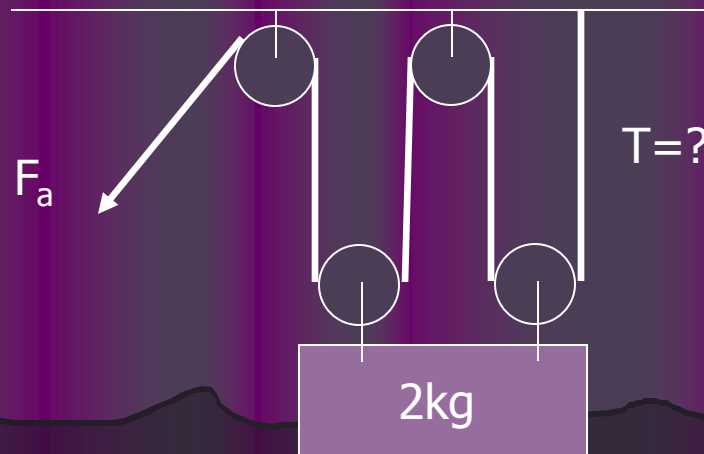
12. What is the acceleration of the system?
13. What is the net force acting on each individual object?
14. Find  $T_1$ .
15. Find  $T_2$ .

# Review Evaluation

1. What is the tension in the string?



2. What is the tension in the string?





# Review Evaluation



3. What is the normal force acting on block #2?
4. What is  $F_{1 \text{ on } 2}$ ?
5. What is  $F_{2 \text{ on } 1}$ ?

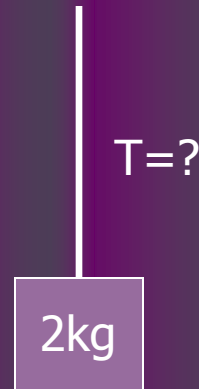
# Review Evaluation



6. What is the acceleration of the system?
7. What is the net force acting on each individual object?
8. What is  $F_{2 \text{ on } 3}$  ?
9. What is  $F_{1 \text{ on } 2}$ ?

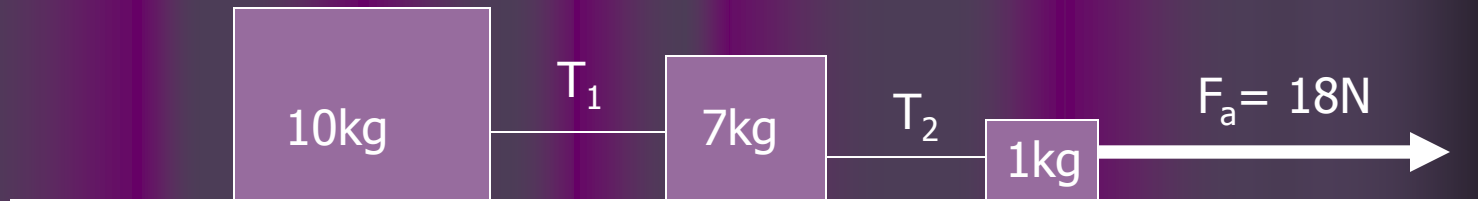
# Review Evaluation

The block is accelerating **upward** at a rate of  $1\text{m/s}^2$ .



10. Find the net force acting on the block.
11. Find T.

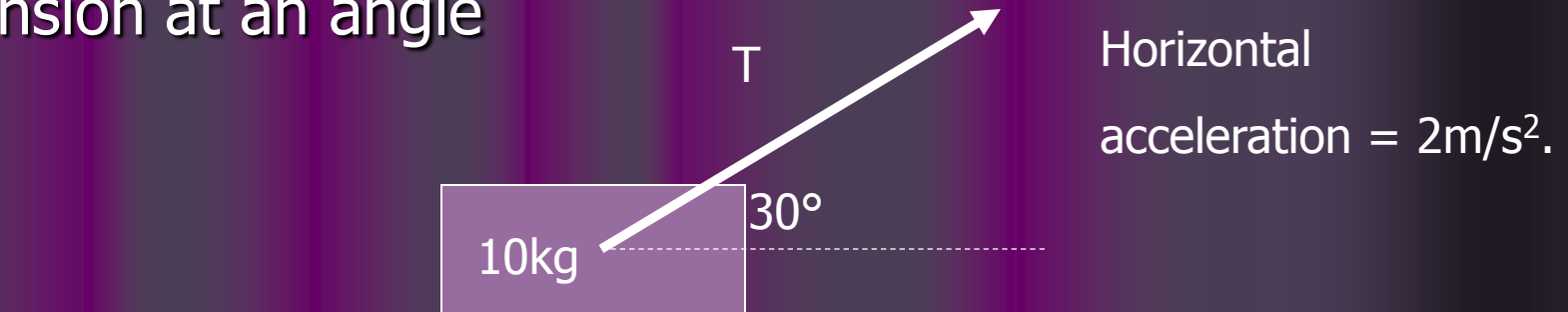
# Review Evaluation



12. What is the acceleration of the system?
13. What is the net force acting on each individual object?
14. Find  $T_1$ .
15. Find  $T_2$ .

# Normal force review

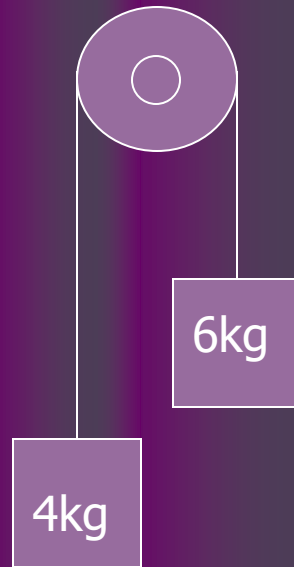
- Tension at an angle



- Split  $T$  into  $x$  and  $y$  components.
- Draw all other forces acting on the object.
- Find  $F_{\text{net}}$ .
- Find  $T$ .
- Find  $F_n$ .

# Practice with tension and systems

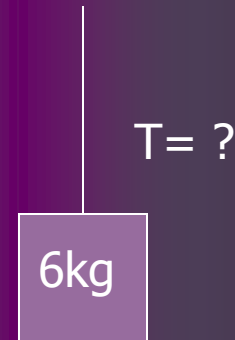
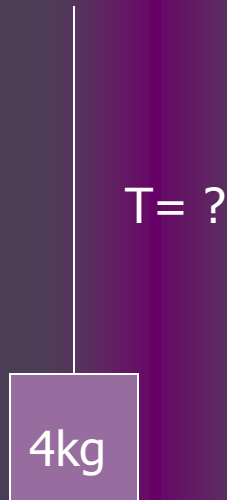
- The Atwood's machine.



- Draw the forces acting on the system.
- Find the net force acting on the system.
- Find the acceleration of the system.

# Practice with tension and systems

- The Atwood's machine.



- Find the net force acting on each individual object.
- To find tension, analyze the forces acting on only one object of the system.

## Lesson #46

### Topic: Lab: Atwood Machine

**Objectives:** (After this class I will be able to)

1. Measure the acceleration of a simple system using a motion detector and compare the measured value to a calculated value.

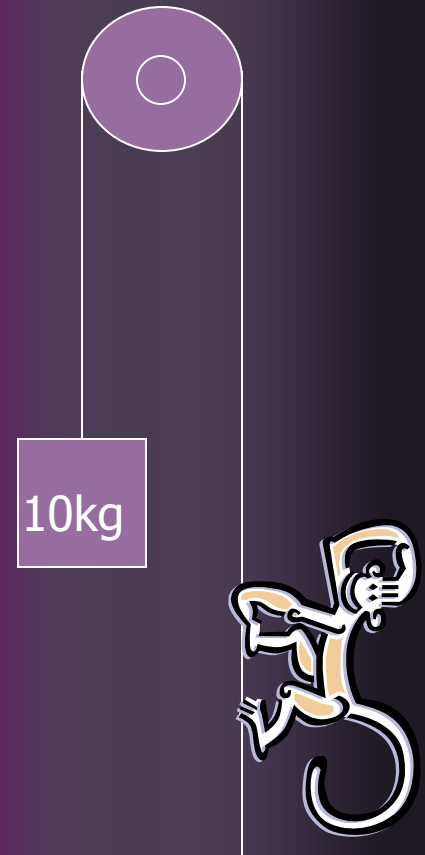
**Lab Task:** Use system problem solving methods to write a net force equation and solve for an unknown variable.

Assignment: Atwood Machine Lab due tomorrow!



# Bonus

- A rope is hung over a pulley. A 10kg block is hung from the one side of the rope, and a 10kg monkey hangs from the other side of the rope. The monkey climbs up his side of the rope with an acceleration of  $1\text{m/s}^2$ . What happens to the 10kg mass on the other side?

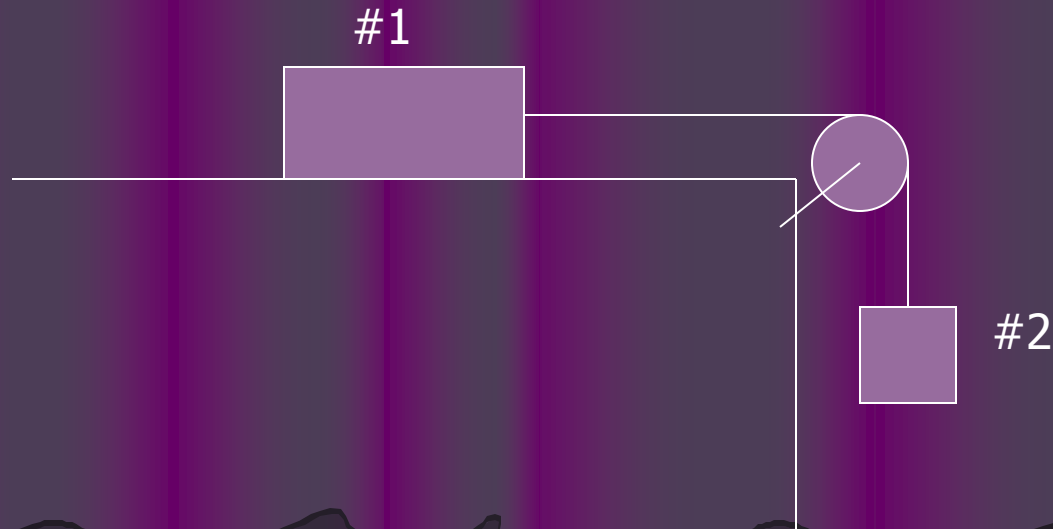


# Warehouse Design

- You have taken a summer job at a warehouse and have designed a method to help get heavy packages up a  $15^\circ$  ramp. In your system a package is attached to a rope which runs parallel to the ramp and over a pulley at the top of the ramp. After passing over the pulley the other end of the rope is attached to a counterweight which hangs straight down. In your design the mass of the counterweight is always adjusted to be twice the mass of the package. Your boss is worried about this pulley system. In particular, she is concerned that the package will be too difficult to handle at the top of the ramp and tells you to calculate its acceleration. To determine the influence of friction between the ramp and the package you run some tests. You find that you can push a 50 kg package with a horizontal force of 250N at a constant speed along a level floor made of the same material as the ramp.

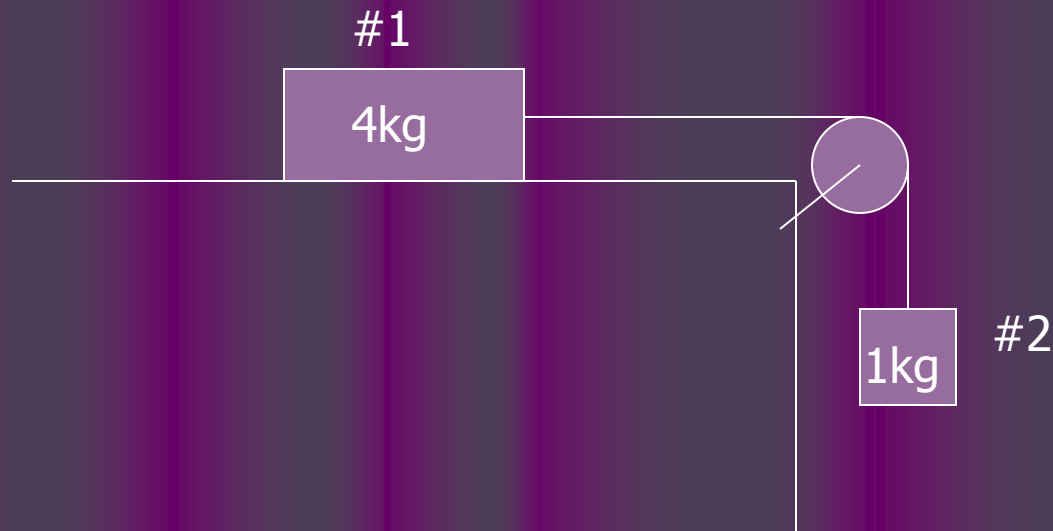
# Project

- Build the set up below with a block of wood (known weight), pulley, string, and hanging weight.
- Calculate the coefficient of friction between the block of wood and table.



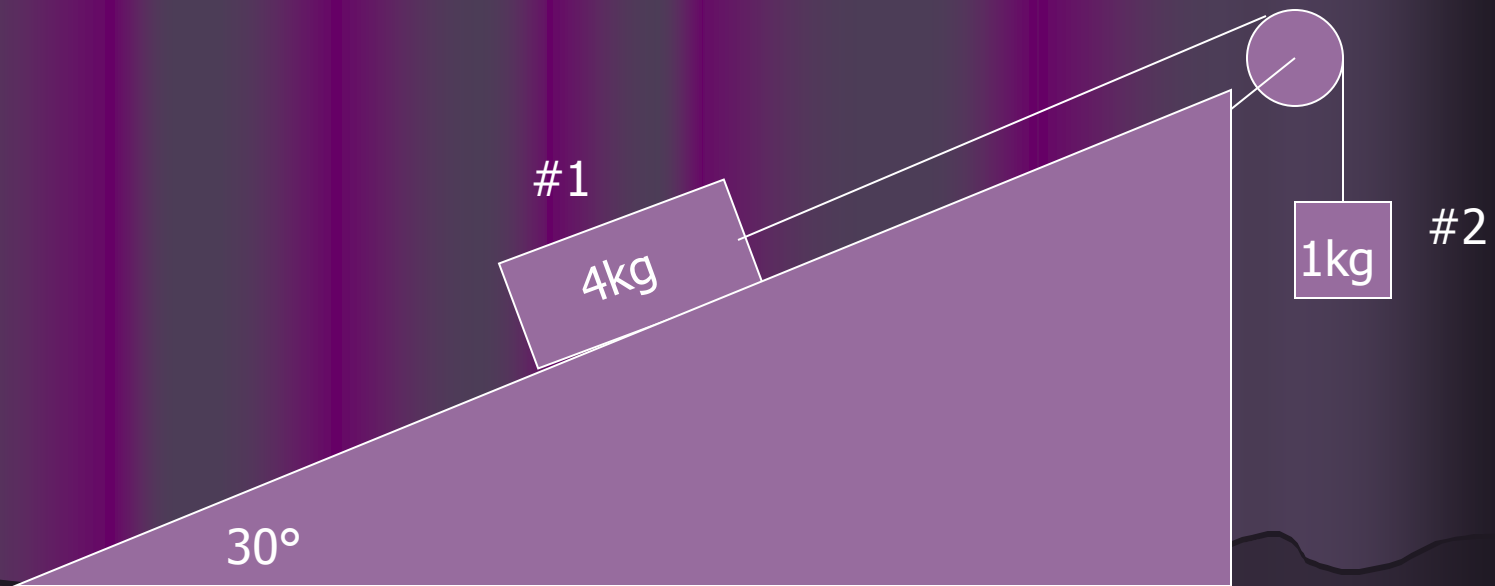
# Challenge Problems

1. What is the coefficient of static friction between block #1 and the table if the system just begins to move?



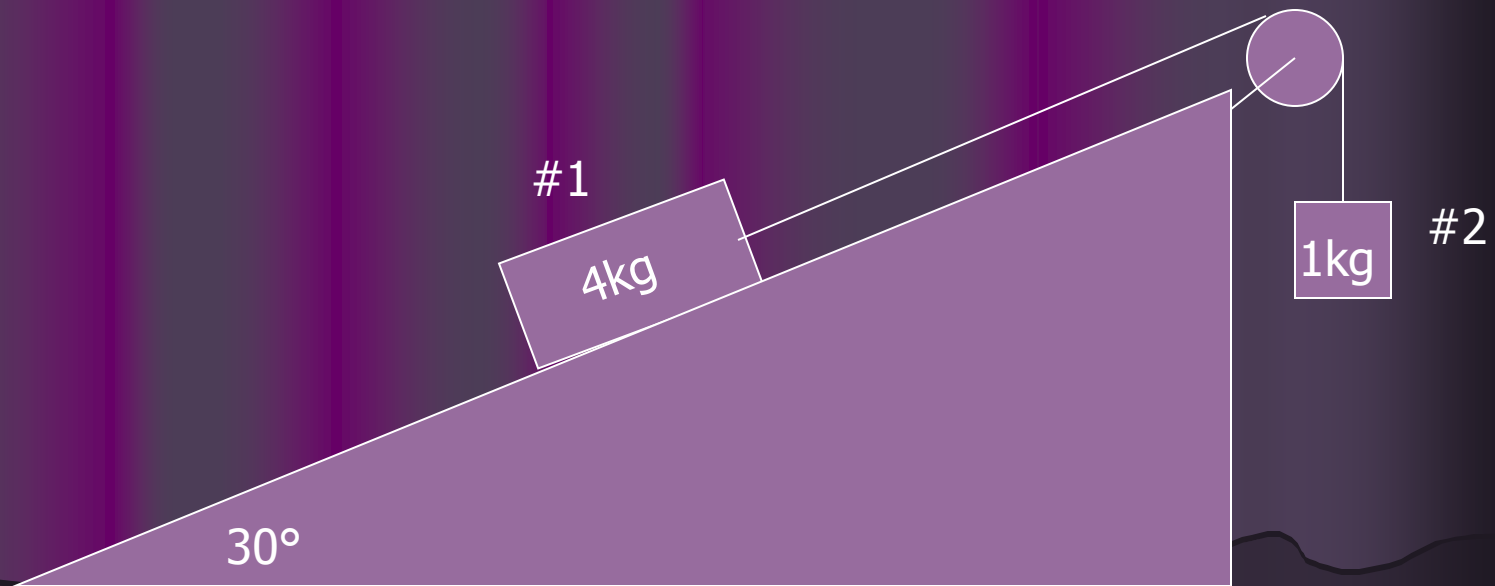
# Challenge Problems

2. Does block #1 move up or down the incline?
3. What is the acceleration of the system? (assume no friction)



# Challenge Problems

4. What is the minimum coefficient of static friction needed to prevent the system from accelerating?



# Warehouse Design

- Find the acceleration of the package as it reaches the worker at the top of the ramp.
- Does this seem like a safe acceleration or unsafe?
- What else would you like to know about the situation to determine if it is safe or not?

## **Objectives:** (After this class I will be able to)

1. Practice solving physics problems
2. Complete and check Exam 6 Review
3. Plan a tutoring time (if needed)
4. Complete a bonus problem opportunity

**Warm Up:** A 10kg block sitting on a table has a string attached to it that hangs off of the edge of the table and connects to a 2kg hanging block. The system moves at **constant speed**. What is the coefficient of kinetic friction between the 10kg block and the table?

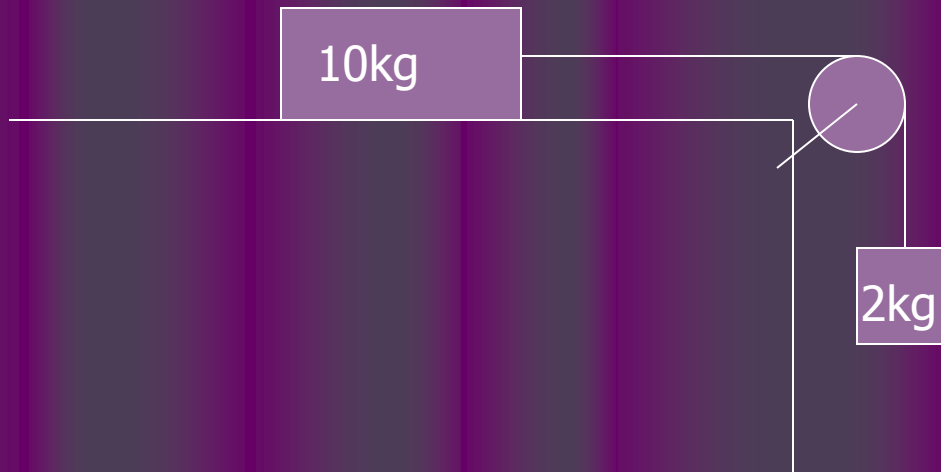
**Assignment:** Exam 6 Review due ! Study for Exam 6.



# Warm Up Solution

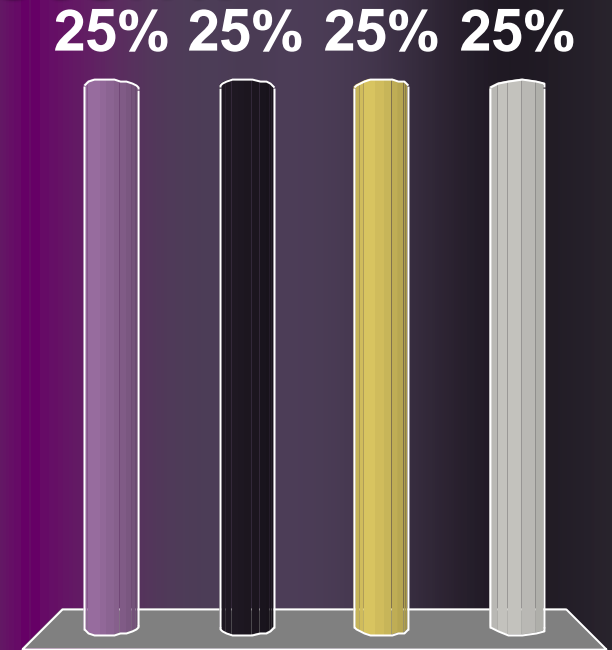
$v = \text{constant}$

$\mu_k = ?$



A 10kg block is along side a 20kg block. An applied force of 10N accelerates the system.

1. They exert the same force on one another.
2. The large block exerts a greater force on the smaller block.
3. The small block exerts a greater force on the large block.
4. It depends on the acceleration of the system.



They exert the same f...

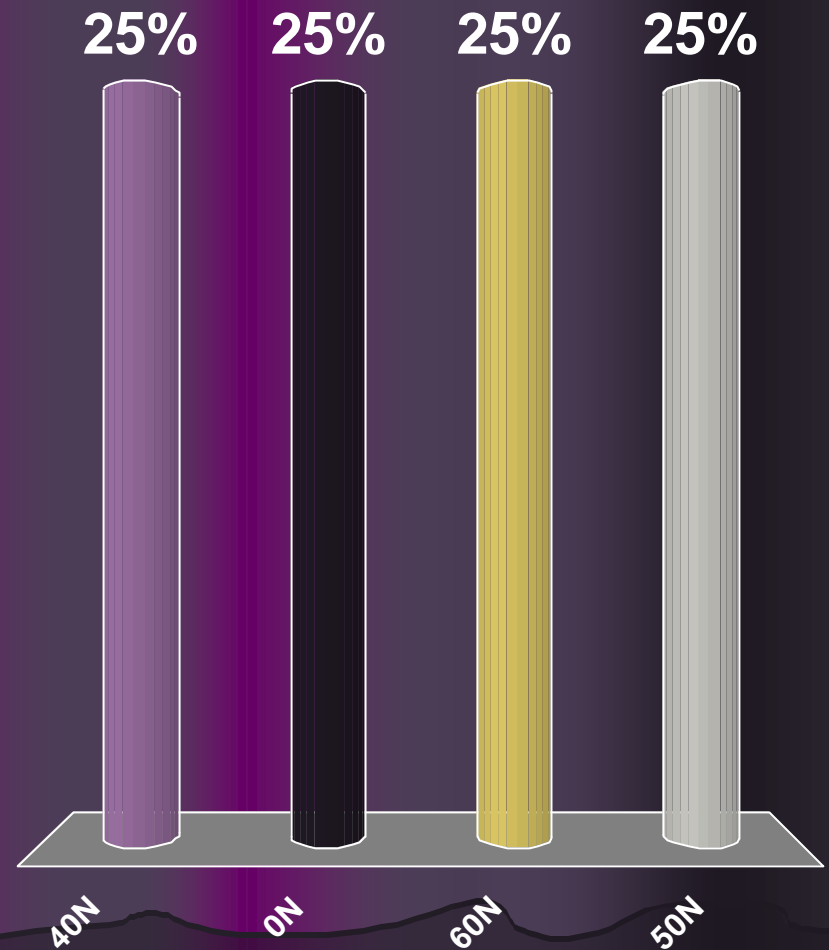
The large block exerts...

The small block exerts...

It depends on the acc...

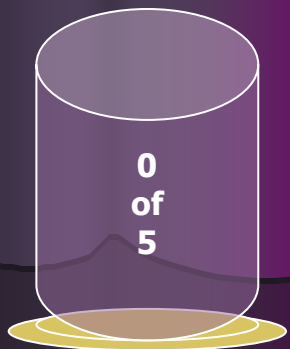
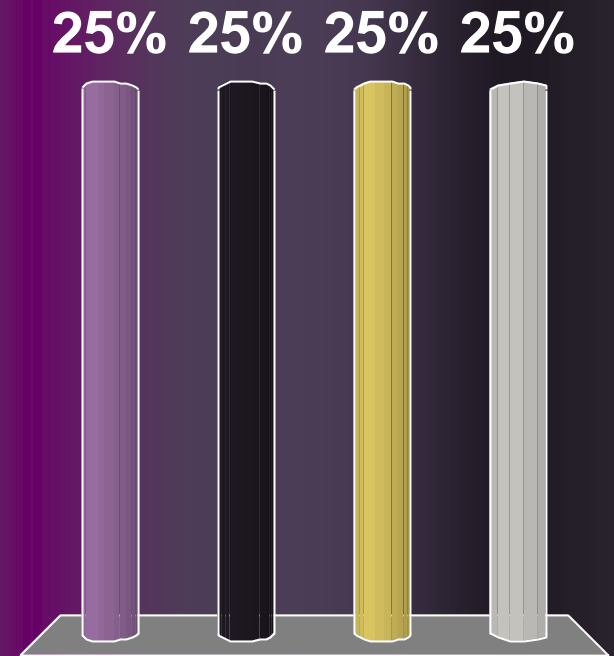
A 5kg block is at rest on a table when an upward tension force of 10N is applied to it. The normal force acting on the block is...

1. 40N
2. 0N
3. 60N
4. 50N



An engine accelerates 2 railroad cars along a track.  
The tension in the couplings between the cars is ...

1. Greatest between the engine and the first car
2. Greatest between the second and first car
3. The same between both cars
4. Depends on the mass of the cars



Greatest between th...

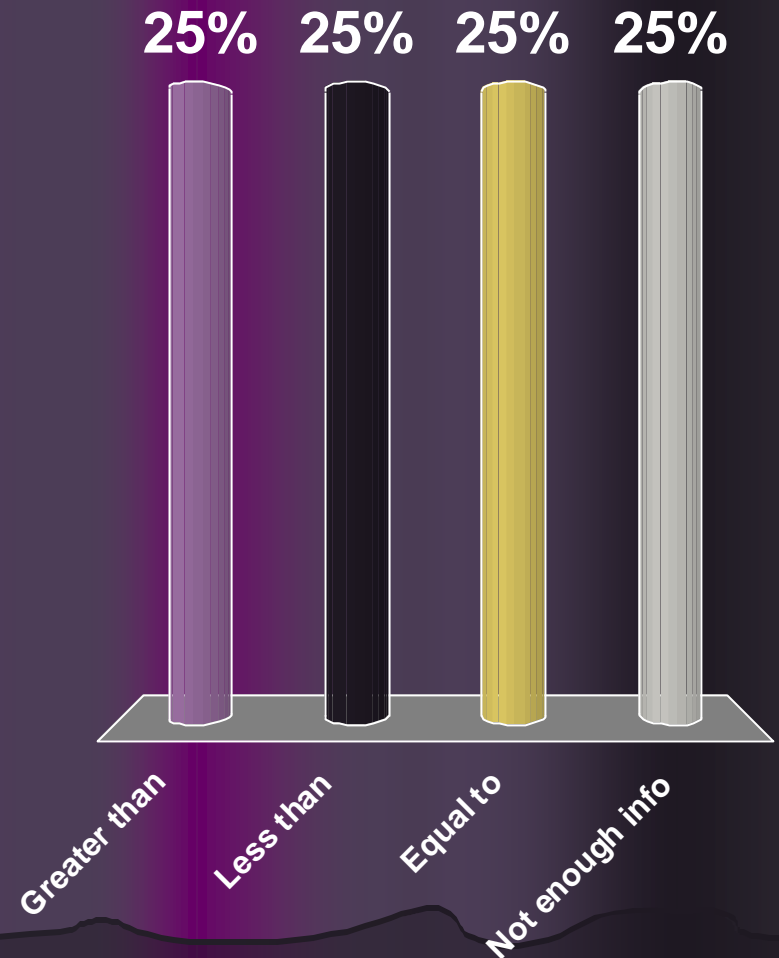
Greatest between the...

The same between b...

Depends on the mass...

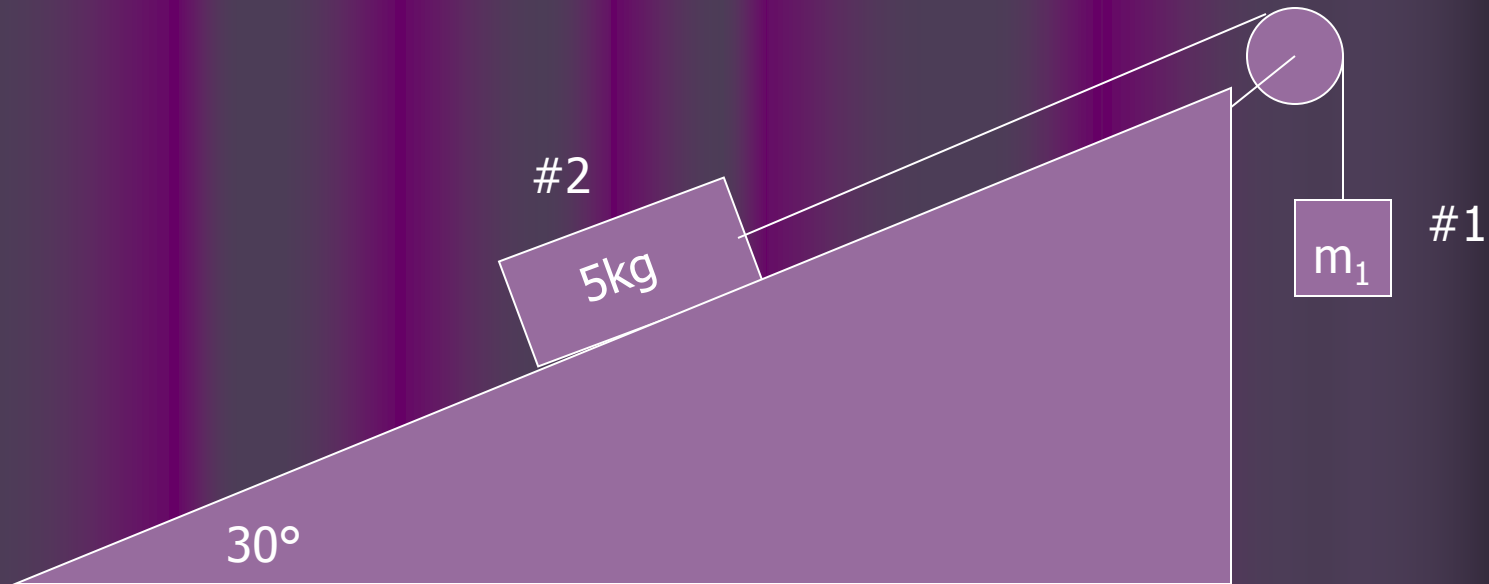
A 5kg cable suspends a 50kg crate from the ceiling. The tension in the cable near the ceiling will be \_\_\_\_\_ the tension in the cable near the crate.

1. Greater than
2. Less than
3. Equal to
4. Not enough info



## Bonus (6pts)

- Find the minimum **and** maximum mass  $m_1$  can have without accelerating the system.  $\mu_s = 0.2$



## Bonus 2 (4pts)

- Find the maximum height the smaller block reaches. Hint: Find the acceleration of the smaller block and calculate its “launch” velocity.

